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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. Fee Transmittal Form
(Submit an original, and a duplicate for fee processing)2. Specification Total Pages **42**3. Drawing(s) (35 USC 113) Total Sheets **16**4. Oath or Declaration Total Pages **1**a. Newly executed (original or copy)b. Unexecuted for information purposesc. Copy from a prior application (37 CFR 1.63(d))
(for continuation/divisional with Box 17 completed)
*[Note Box 5 below]*i. **DELETION OF INVENTOR(S)**Signed Statement attached deleting inventor(s)
named in the prior application, see 37 CFR
1.63(d)(2) and 1.33(b).5. Incorporation By Reference (useable if Box 4c is checked)
The entire disclosure of the prior application, from which a copy of the
oath or declaration is supplied under Box 4c, is considered as being
part of the disclosure of the accompanying application and is hereby
incorporated by reference therein.Attorney Docket No. **35.C14671**

First Named Inventor or Application Identifier

HIROCHIKA MATSUOKA

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Washington, DC 20231**ADDRESS TO:**6. Microfiche Computer Program (*Appendix*)7. Nucleotide and/or Amino Acid Sequence Submission
(if applicable, all necessary)a. Computer Readable Copyb. Paper Copy (identical to computer copy)c. Statement verifying identity of above copies**ACCOMPANYING APPLICATION PARTS**8. Assignment Papers (cover sheet & document(s))9. 37 CFR 3.73(b) Statement
(when there is an assignee) Power of Attorney10. English Translation Document (if applicable)11. Information Disclosure Statement (IDS)/PTO-1449 Copies of IDS Citations12. Preliminary Amendment13. Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)14. Small Entity Statement filed in prior application
Statement(s) Status still proper and desired15. Certified Copy of Priority Document(s)
(if foreign priority is claimed)16. Other: _____

17. If a CONTINUING APPLICATION, check appropriate box and supply the requisite information:

 Continuation Divisional Continuation-in-part (CIP) of prior application No. /_____**18. CORRESPONDENCE ADDRESS**

<input checked="" type="checkbox"/> Customer Number or Bar Code Label	05514 (Insert Customer No. or Attach barcode label here)	or <input type="checkbox"/> Correspondence address below
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CLAIMS	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
	TOTAL CLAIMS (37 CFR 1.16(c))	13-20 =	0	X \$ 18.00 =	\$0
	INDEPENDENT CLAIMS (37 CFR 1.16(b))	6-3 =	3	X \$ 78.00 =	\$234.00
	MULTIPLE DEPENDENT CLAIMS (if applicable) (37 CFR 1.16(d))			\$260.00 =	\$0
				BASIC FEE (37 CFR 1.16(a))	\$690.00
				Total of above Calculations =	\$924.00
	Reduction by 50% for filing by small entity (Note 37 CFR 1.9, 1.27, 1.28).				0
				TOTAL =	\$924.00

19. Small entity status

- a. A Small entity statement is enclosed
- b. A small entity statement was filed in the prior nonprovisional application and such status is still proper and desired.
- c. Is no longer claimed.

20. A check in the amount of \$ 924.00 to cover the filing fee is enclosed.

21. A check in the amount of \$ _____ to cover the recordal fee is enclosed.

22. The Commissioner is hereby authorized to credit overpayments or charge the following fees to Deposit Account No. 06-1205:

- a. Fees required under 37 CFR 1.16.
- b. Fees required under 37 CFR 1.17.
- c. Fees required under 37 CFR 1.18.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED	
NAME	Jack M. Arnold
SIGNATURE	<i>Jack M. Arnold Pg # 25, 823</i>
DATE	July 27, 2000

PATCH IMAGE PREPARATION METHOD
AND RECORDING MEDIUM THEREFOR

BACKGROUND OF THE INVENTION

5 Field of the Invention

The present invention relates to the preparation of a patch image.

Related Background Art

The color DTP is recently becoming popular with a computer system, as a result of recent advances in the color reproducing ability of the computer and in the performance of the color printers. In such field there are employed a calibration technology for the color printer for the purpose of realizing exact color reproduction and the preparation of a printer model for the color printer for the purpose of realizing more exact color matching, but either technology involves such steps as preparation of a patch image, output of the prepared patch image and measurement of the outputted patch image. However, exact measurement of the patch image is impossible because a noise is always involved in the output of the patch image. Therefore, assuming that the noise is white noise, the influence of noise is relaxed by outputting and measuring the same patch image plural times. Otherwise the influence of the noise is relaxed by outputting the patch image with a rotation process

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plural times and measuring such patch image.

It is however not reasonable to assume that the noise color signal (hereinafter called noise) mixed in the patch image is white noise, since such noise is strongly correlated with the color of the patch.

5 strongly correlated with the color of the patch.

Consequently, the relaxation of the influence of noise is inevitably limited even if the same image is outputted many times. It is therefore necessary to prepare a patch image in consideration of the correlation of the noise. Also in consideration of the convenience in practical use, the number of the patch images should be as small as possible. There is thus required a patch image preparing method capable of relaxing the influence of noise taking the correlation of the noise into consideration and utilizing the patch images of a number as small as possible.

SUMMARY OF THE INVENTION

20 In consideration of the foregoing, the object of
the present invention is to relax the influence of
noise, taking the correlation of the noise in
consideration and utilizing the patch images of a
number as small as possible.

25 For attaining the above-mentioned object, the present invention is featured by the following constituent factors.

According to a first invention of the present application, there is provided a patch image preparation method for preparing a patch image to be used for generating image processing data, wherein the 5 patch image includes plural patches relating to a same color, and the plural patches of the same color are so arranged as to decrease the mutual influence of the noise color signals resulting from the self correlation of the noise color signal in the plural 10 patches of the same color.

According to a second invention of the present application, there is provided a patch image preparation method for preparing a patch image including plural patches of a same color to be used 15 for generating image processing data, wherein the plural patches of the same color are so arranged as to decrease the mutual influence of the noise color signals resulting from the self correlation of the noise color signal in the plural patches of the same 20 color.

According to a third invention of the present application, there is provided a patch image preparation method for preparing a patch image including plural patches of a same color, wherein, for 25 each patch color, the patches are so arranged as to decrease the mutual influence of the noise color signals resulting from the self correlation of the

noise color signal in the patch color in such a manner that the noise color signal in the patch color can be equivalently approximated by white noise.

According to a fourth invention of the present
5 application, there is provided a method of preparing a basic patch image for a color to be used as a patch, preparing a rotated image by applying a rotation operation to the basic patch image and arranging the rotated image at an appropriate image position.

10 Other objects of the present invention, and the features thereof, will become fully apparent from the following detailed description which is to be taken in conjunction with the accompanying drawings.

15 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing the system configuration of a patch image output/measuring apparatus in a first embodiment;

20 Fig. 2 is a flow chart showing the algorithm of a patch image preparation method of the first embodiment;

Fig. 3 is a view showing an example of the arrangement non-permission area in the first embodiment;

25 Fig. 4 is a view showing an example of the arrangeable area in the first embodiment;

Fig. 5 is a view showing an example of the

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arrangement non-permission area in the first embodiment;

Fig. 6 is a view showing an example of the arrangement candidate area in the first embodiment;

5 Fig. 7 is a view showing an example of the
arrangement non-permission area for a rearranged patch
in the first embodiment:

Fig. 8 is a view showing an example of the arrangeable area for a rearranged patch in the first embodiment:

Fig. 9 is a chart schematically showing a self correlation function, in the main scanning direction, of the noise color signal mixed in a color, and showing the relationship between a certain threshold value and a threshold value Th_m in the main scanning direction;

Fig. 10 is a chart schematically showing a self correlation function, in the sub scanning direction, of the noise color signal mixed in a color, and showing the relationship between a certain threshold value and a threshold value Th_s in the sub scanning direction.

Fig. 11 is a view showing an example of the arrangement non-permission area in a second embodiment:

Fig. 12 is a view showing an example of the arrangement candidate area in the second embodiment;

Fig. 13 is a view showing an example of the arrangement non-permission area for a rearranged patch in the second embodiment;

5 Fig. 14 is a view showing an example of the arrangeable area for a rearranged patch in the second embodiment;

Fig. 15 is a flow chart showing the algorithm of a patch image preparation method of a third embodiment;

10 Fig. 16 is a view showing a basic patch image and a rotated image in the third embodiment;

Fig. 17 is a view showing the arrangement spot of the rotated image in the third embodiment;

15 Fig. 18 is a flow chart showing the algorithm of a patch image preparation method of a fourth embodiment;

Fig. 19 is a view showing the arrangement of patches in a block image in the fourth embodiment;

20 Fig. 20 is a view showing an example of the arrangement non-permission area in the fourth embodiment;

Fig. 21 is a view showing an example of the arrangeable area in the fourth embodiment;

25 Fig. 22 is a view showing an example of the arrangement non-permission area in the fourth embodiment;

Fig. 23 is a view showing an example of the

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arrangement candidate area in the fourth embodiment;

Fig. 24 is a view showing an example of the arrangement non-permission area for a rearranged patch in the fourth embodiment; and

5 Fig. 25 is a view showing an example of the arrangeable area for a rearranged patch in the first embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

10 In the following there will be explained, with reference to the accompanying drawings, embodiments of system configurations of a patch image output/measurement apparatus.

15 Such patch image output/measurement apparatus is used for preparing a printer model of a color printer, or generation of image processing data such as calibration of the color correcting condition.

20 The calibration is to cause the color printer to output a desired test patch, to measure the color of the outputted test patch, to judge the current color reproducing characteristics of the color printer from the result of such color measurement, and to optimize the color correcting condition.

25 Therefore, in case of applying the following embodiments to the calibration, the application is made in outputting the desired test patch.

[First Embodiment]

Fig. 1 is a block diagram showing the configuration of a patch image output/measurement apparatus constituting a first embodiment of the present invention, wherein provided are a CPU 101, a 5 ROM 102, a main memory 103, a SCSI interface 104, an HDD 105, a graphic accelerator 106, a color monitor 107, a USB controller 108, a color printer 109, a parallel port controller 110, a scanner 111, a keyboard/mouse controller 112, a keyboard 113, a mouse 10 114, and a PCI bus 115. The CPU 101 executes various processings to be explained later according to program/data held in the ROM 102 and the HDD 105.

In the above-described configuration, when the user instructs the CPU 101 through the keyboard 113 15 and the mouse 110 to output a patch, the CPU 101 reads a patch preparation program from the HDD 105 and prepares at least a patch image according to the algorithm, to be explained later, stored in the patch preparation program. The prepared patch image is 20 stored in the main memory 103. On the other hand, the order of color arrangement in the patch image is stored in the HDD 105. Thereafter the CPU transfers the patch image, stored in the main memory 103, to the printer 109 through the PCI bus 115 and the USB 25 controller 108 and instructs the output in a designated mode. According to such instruction, the printer 109 outputs the patch image. Then the user

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sets the outputted patch print on the scanner 111 in a predetermined direction of sheet, and instructs the CPU 101 through the keyboard 113 and the mouse 114 to execute the patch measurement. According to the
5 instruction, the CPU 101 instructs the scanner 111, through the PCI bus 115 and the parallel port controller 110, to execute scanning of the patch image. The image scanned according to the instruction is transferred from the scanner 111 to the main memory 103 through the parallel port controller and the PCI bus. When the transfer of the scanned image to the main memory 103 is completed, the CPU 101 executes image processing on the scanned image in the main memory 103, thereby detecting each patch and acquiring
10 the color signal information, and stores the color signal information of the patch, obtained as the result, in the HDD 105. After these operations, the CPU 101 reads the patch color signal information and the color arrangement order of the patch image from the HDD 105, then executes information processing on the color signal information according to an algorithm instructed by the program, and stores the result of the information processing as the result of patch color measurement in the HDD 105, whereupon the
15 sequence is completed. The algorithm will be explained later.

The result of the information processing stored

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in the HDD 105 is used for the preparation of the printer model of the aforementioned color printer or for the calibration.

In the following there will be explained the
5 patch preparation algorithm with reference to Fig. 2. The algorithm is principally composed of two loops. A loop proceeding from a step S203 to a step S212 and returning to the step S203 (hereinafter called a color arrangement loop) executes the color arrangement once
10 for all the colors outputted as patches. A loop proceeding from a step S202 to a step S213 and returning to the step S202 (hereinafter called a main loop), including the aforementioned color arrangement loop, repeats the aforementioned color arrangement
15 operation plural times, thereby preparing a patch image in which all the colors are outputted plural times. Each of the steps will be explained in the following.

A step S201 executes securing of a work memory
20 area and initialization of work variables, for the patch preparation. The step S202 determines an order of arranging colors (hereinafter called color arrangement order) in random manner in the color arrangement loop. The step S203 determines colors to
25 be arranged (arrangement colors) based on the color arrangement order determined in the step S202 and the number of repetition in the color arrangement loop.

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The step S201 executes securing of a work memory area and initialization of work variables, for the patch preparation. The work variables include the kind of arrangement colors, the number of repetition of the color arrangement loop etc.

5 The kind of the arrangement colors and the number of repetition of the color arrangement loop may be designated by the user, utilizing a user interface of a software realizing the patch preparation algorithm 10 of the present embodiment. An increase in the number of the prepared patches allows to execute the subsequent processes in a higher precision, but there increases the time required for the patch preparation and the color measurement.

15 Consequently, the designation of various conditions by the user allows to execute the patch formation according to the purpose of the user.

A step S204 determines an arrangement non-permission area Af corresponding to the concerned-color patch.

20 A step S204 determines an arrangement non-permission area Af corresponding to the concerned-color patch.

It was experimentally found that the noise has correlation in the main and sub scanning directions. In the following there will be explained, with reference to Fig. 3, a method for deriving the arrangement non-permission area Af based on such fact.

25 The arrangement non-permission area Af is determined as a sum of the following two areas

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respectively in the main scanning direction and in the
sub scanning direction;

- area 1: an area A_u already with color
arrangement, as indicated as a grid
pattern area shown in Fig. 3; and
5 area 2: an area A_c having a high correlation
 with the already arranged
 concerned-color patch at the arrangement
 of the concerned arrangement color C_p ,
10 as indicated by a hatched area in Fig.
 3.

In Fig. 3, $Th_m(C_p)$ and $Th_s(C_p)$ respectively
indicate a threshold value in the main scanning
direction and a threshold value in the sub scanning
15 direction, for a concerned-color calculated in
 advance. The method of deriving these threshold
 values will be explained later.

A step S205 calculates an arrangeable area A_a , by
eliminating the arrangement non-permission area A_f
20 from the entire patch arrangement area A . There are
 obtained the areas A_u and A_c shown in Fig. 3, and Fig.
 4 shows the arrangeable area A_a when the arrangement
 non-permission area A_f is given from these two areas.
 The sequence jumps to a step S206 or the step S212
25 respectively if the area A_a is vacant or not.

The step S206 determines an arrangement candidate
area A_e by reducing the area A_c form the area A . In

case the area A_c becomes as shown in Fig. 5, the arrangement candidate area A_c becomes as shown in Fig.

6. A step S207 determines, in the arrangement candidate area Ae, an arrangement candidate spot for

5 the concerned arrangement color in a random manner. A
step S208 acquires the color C_e of a patch
(hereinafter called rearrangement patch) already
arranged in the arrangement candidate spot, and
discriminates whether the acquired color C_e can be
0 rearranged. Such discrimination will be explained
with reference to Figs. 7 and 8.

There is calculated an area Ac_c , other than the arrangement candidate spot, having a high correlation with the already arranged color patch Ce . Then there
15 is determined an area Ac_s as a sum of the above-mentioned area and the area Au in which the color is already arranged, and a rearrangeable area Ac_a is calculated by reducing the area Ac_s from the entire patch arrangement area A . For example, if the area Ac_s is given as shown in Fig. 7, the rearrangeable area Ac_a is given as shown in Fig. 8. The rearrangement
20 is judged impossible or possible respectively if the area Ac_a is vacant or not.

The sequence jumps to a step S211 or S208
25 respectively if the rearrangement is judged possible
or impossible.

A step S209 reduces the arrangement candidate

spot from the arrangement candidate area Ae. A step S210 discriminates that the patch preparation failed if the area Ae becomes vacant, whereupon the sequence jumps to the step S201.

5 If it is not vacant, the sequence jumps to the
step S207. The step S211 rearranges the rearrangement
patch randomly in the area Ac_a, and then arranges the
concerned arrangement color in the arrangement
candidate spot. Thereafter the sequence jumps to the
10 step S213.

The step S212 randomly arranges the concerned
arrangement color in the arrangeable area Aa, and the
sequence jumps to the step S213. If the step S213
identifies that the patch arrangement is completed for
15 all the colors used as the patches, the sequence
proceeds to a step S214. If the step S214 identifies
that the arrangement of all the color patches has been
executed for a predetermined number of times, the
sequence proceeds to a step S215, but, if such
20 predetermined number has not been reached, the
sequence proceeds to the step S202. The step S215
completes the patch image preparation.

In the following there will be explained the
method for deriving the threshold value Th_m in the
25 main scanning direction and the threshold value Th_s
in the sub scanning direction for each patch color.
For each color, the threshold value Th_m is determined

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from the correlation between the noise and the main scanning direction and from the dispersion of the noise, and the threshold value Th_s is determined from the correlation between the noise and the sub scanning direction and from the dispersion of the noise.

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In calculating the threshold value Th_m, there is at first calculated the correlation function fm(x) between the noise and the main scanning direction in the following manner:

$$fm(x) = \frac{1}{Rm} \iint n(s, t) (s+x, t) ds dt$$

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wherein n(s, t) indicates the noise signal at a position s in the x-direction and a position t in the y-direction, and Rm is a normalizing constant.

15

Then the correlation function fm(x) is normalized in the following manner by the noise dispersion v, thereby obtaining a function fmn(x):

$$fmn(x) = fm(x) v$$

20

Then there is determined a value x for which the function fmn(x) becomes lower than a certain threshold value, and such value x is defined as the threshold value Th_m. This relationship is shown in Fig. 9. In the present embodiment, the above-mentioned threshold value is experimentally determined in advance.

25

Then, for calculating the threshold value Th_s, there is at first calculated the correlation function

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fs(y) between the noise and the sub scanning direction
in the following manner:

$$fs(y) = \frac{1}{Rs} \iint n(s, t) (s, t+y) ds dt$$

wherein Rs is a normalizing constant.

5 Then the correlation function fs(y) is normalized
in the following manner by the noise dispersion v,
thereby obtaining a function fsn(x):

$$fsn(x) = fs(x) v$$

10 Then there is determined a value y for which the
function fsn(y) becomes lower than a certain threshold
value, and such value y is defined as the threshold
value Th_s. This relationship is shown in Fig. 10.

15 In the following there will be explained the
algorithm of information processing on the patch color
signal information. In the patch image formation, by
outputting the patch images through image formation
utilizing the patch n times for each color, the patch
color signal information representing the measurement
of such patch images can be obtained in n samples for
each color. The result c(C) of the information
20 processing can be obtained by the following averaging
calculation:

$$c(C) = \frac{1}{n} \sum_i s(C, i)$$

wherein $s(C, i)$ is the patch color signal information of an i -th sample for a color C .

Such result $c(C)$ of the information processing is defined as the result of patch color measurement.

5 The present embodiment allows, by patch arrangement in consideration of the self correlation of the noise for each patch color in the patch image preparation, to relax the influence of noise in the patch measurement thereby improving the efficiency and
10 the accuracy.

[Second Embodiment]

The present embodiment modifies the algorithm of patch preparation in the first embodiment, thereby enabling preparation of plural patch images. In the
15 following there will be explained the patch preparation algorithm alone with reference to Fig. 2.

The step S201 executes securing of a work memory area and initialization of work variables, for the patch preparation. The step S202 randomly determines
20 the order of arranging colors (hereinafter called color arrangement order) in the color arrangement loop.

The step S203 determines a color C_p to be arranged (arrangement color) from the color
25 arrangement order determined in the step S202 and the number of repetition in the color arrangement loop.

The step S204 determines an arrangement non-

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permission area for the concerned arrangement color Cp. The deriving method for the arrangement non-permission area Af will be explained with reference to Fig. 11. The arrangement non-permission area Af is determined as a sum of the following two areas:

5 area 1: an area Aua already with color arrangement over all the pages, as indicated as a grid pattern area in Fig. 11; and

10 area 2: an area Ac having a high correlation with the already arranged concerned-color patch at the arrangement of the concerned arrangement color Cp, as indicated by a hatched area in Fig. 11.

15 The following area is not included in the arrangement non-permission area Af, since, if a patch is arranged in a certain page, the arrangement is possible in the same area in another page:

20 area 3: an area Aup in which the block is arranged in a part of the pages, as indicated by a dotted area in Fig. 20.

25 In Fig. 11, $Th_m(Cp)$ and $Th_s(Cp)$ respectively indicate a threshold value in the main scanning direction and a threshold value in the sub scanning direction, for a concerned color, calculated in advance. The method of deriving these threshold

values will be explained later.

The step S205 calculates an arrangeable area Aa, by reducing the arrangement non-permission area Af from the entire patch arrangement area A. Fig. 12
5 shows the arrangeable area Aa for the arrangement non-permission area shown in Fig. 11. The sequence proceeds to the step S206 or the step S212 respectively if the area Aa is vacant or not.

The step S206 determines an arrangement candidate area Ae by reducing the area Ac from the area A. The
10 step S207 randomly determines, in the arrangement candidate area Ae, an arrangement candidate page and a arrangement candidate spot for the concerned arrangement color.

15 The step S208 acquires the color Ce of a patch (hereinafter called rearrangement patch) already arranged in the arrangement candidate page and the arrangement candidate spot, and discriminates whether the acquired color Ce can be rearranged. Such
20 discrimination will be explained with reference to Figs. 13 and 14.

There is calculated an area Ac_c, other than the arrangement candidate spot, having a high correlation with the already arranged color patch Ce. Then there
25 is determined an area Ac_s as a sum of the above-mentioned area and the area Aus in which the color is already arranged over all the pages, and a

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5 rearrangeable area Ac_a is calculated by reducing the area Ac_s from the entire patch arrangement area A . For example, if the area Ac_s is given as shown in Fig. 13, the rearrangeable area Ac_a is given as shown
in Fig. 14. The rearrangement is judged impossible or possible respectively if the area Ac_a is vacant or not.

10 The sequence proceeds to the step S211 or S208 respectively if the rearrangement is judged possible or impossible. The step S209 reduces the arrangement candidate spot from the arrangement candidate area A_e . The step S210 discriminates that the patch preparation failed if the area A_e becomes vacant, whereupon the sequence proceeds to the step S201. If it is not
15 vacant, the sequence proceeds to the step S207. The step S211 rearranges the rearrangement patch C_e randomly in the area Ac_a , and also randomly determines the page of arrangement, excluding the page in which the color is already arranged in the arrangement spot.
20 Thereafter the concerned arrangement color is arranged in the arrangement candidate spot, and the sequence proceeds to the step S213.

25 The step S212 randomly arranges the concerned arrangement color in the arrangeable area A_a , and also randomly determines the arrangement page, excluding the page in which the color is already arranged in the arrangement spot. Thereafter the sequence proceeds to

the step S213.

If the step S213 identifies that the patch arrangement is completed for all the colors used as the patches, the sequence proceeds to the step S214, but, if the arrangement is not complete, the sequence proceeds to the step S203. If the step S214 identifies that the arrangement of all the color patches has been executed for a predetermined number of times, the sequence proceeds to the step S215, but, if such predetermined number has not been reached, the sequence proceeds to the step S203. The step S215 completes the patch image preparation.

The present embodiment allows to improve the accuracy in comparison with the first embodiment, by preparing plural patch images.

[Third Embodiment]

The present embodiment provides a modification of the patch preparation algorithm of the first embodiment. In the following there will therefore be explained the patch preparation algorithm only with reference to Fig. 15.

The algorithm shown in Fig. 15 is principally composed of two loops. A loop proceeding from a step S305 to a step S311 and returning to a step S306 (hereinafter called a color arrangement loop) executes preparation of a patch image by arranging one or plural images obtained by a rotating process

(hereinafter called rotated image) on the basic patch image. A loop proceeding from a step S304 to a step S313 and returning to the step S305 (hereinafter called a main loop), including the aforementioned 5 color arrangement loop, executes the aforementioned color arrangement operation plural times or once, thereby preparing plural or one patch image. Each of the steps will be explained in the following.

A step S301 executes securing of a work memory 10 area and initialization of work variables, for the patch preparation. A step S302 determines variables L, M and N, in which L indicates the number of the patch images. M and N determine the number of arrangement of the rotated images in a patch image, 15 wherein M is the number of arrangement of the rotated images in the y-direction and N is the number of arrangement of the rotated images in the x-direction. Thus the number of arrangement of the rotated images in a patch image is given by $M \times N$.

20 A step S303 prepares a basic patch image I_{org} . The basic patch image I_{org} have I patches in the y-direction and J patches in the x-direction, thus containing $I \times J$ patches in total. The size of the patch is selected as $P_x \times P_y$. The step S304 sets $l = 25 0$, then the step S305 sets $m = 0$, and the step S306 sets $n = 0$.

A step S307 executes a rotating operation on the

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basic patch image Iorg, thereby preparing a rotated image Inml. The rotation amount Rx in the x-direction and the rotation amount Ry in the y-direction are determined from l, m and n according to the following
5 equations, in which parentheses [] indicates a function of discarding the fractional part and taking the integral part only:

$$Rx = Px \times \left[\frac{J}{LN} (1N+n) \right]$$

$$Ry = Py \times \left[\frac{I}{LM} (1M+m) \right]$$

10 Fig. 16 shows the relationship between the basic patch image and the rotated image Inml.

A step S308 arranges the rotated image Inml, obtained in the step S307, in a predetermined position. The upper left corner of the rotated image
15 Inml is at a position displaced, from the upper left corner of the patch image, by $Px \times J \times n$ to the right and by $Py \times I \times m$ to below.

A step S309 discriminates whether the current value of n is equal to N - 1, and, if equal, the
20 sequence proceeds to the step S311, but, if not equal, the sequence proceeds to a step S310. The step S310 adds 1 to the current value of n and the sequence proceeds to the step S307. The step S311

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discriminates whether the current value of m is equal to $M - 1$, and, if equal, the sequence proceeds to the step S313, but, if not equal, the sequence proceeds to a step S312. The step S312 adds 1 to the current
5 value of m and the sequence proceeds to the step S306. The step S313 discriminates whether the current value of l is equal to $L - 1$, and, if equal, the sequence proceeds to a step S315, but, if not equal, the
proceeds to a step S314. The step S314 adds
10 to the current value of l and the sequence proceeds to the step S305. The step S315 completes the preparation of the patch image.

The present embodiment enables easy preparation of the patch image, and allows to relax the influence
15 of noise on all the colors in average, by executing regular arrangement. Also as the relationship between the accuracy and the number of the patch images is made clear, it is made easier for the user to effect selection between the accuracy and the cumbersomeness.
20 Also the arrangement order information can be significantly reduced by the use of regular arrangement.

[Fourth Embodiment]

The present embodiment provides a modification of
25 the patch preparation algorithm of the first embodiment. In the following there will be explained such algorithm with reference to Figs. 18 to 25.

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The present embodiment is to prepare a block image containing plural patches and then to arrange such block image, thereby alleviating the load of calculation required for patch arrangement.

5 In the following there will be explained the patch preparation algorithm with reference to Fig. 18. The algorithm is principally composed of two loops. A loop proceeding from a step S404 to a step S415 and returning to the step S404 (hereinafter called an arrangement loop) executes the color arrangement once for all the blocks. A loop proceeding from a step S403 to a step S416 and returning to the step S403 (hereinafter called a main loop), including the aforementioned color arrangement loop, repeats the aforementioned arrangement operation plural times, thereby preparing patch images on plural pages, in which all the blocks are outputted plural times.
10 Each of the steps will be explained in the following.

15 A step S401 executes securing of a work memory area and initialization of work variables, for the patch preparation.

20 A step S402 prepares a block image (hereinafter called a block), containing plural patches, in such a manner that the product set of arbitrary blocks is vacant and that the sum set of all the blocks becomes the set of all the patches. As an example, there will be explained the block preparation rule in case of
25

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preparing patches of 1000 colors. At first patch numbers 1 - 1000 are assigned to the color patches. Then the image of each block is formed by assigning patch numbers $4i-3$, $4i-2$, $4i-1$ and $4i$ to the block of 5 a number i as shown in Fig. 19. In this manner there are formed 250 blocks.

The step S403 executes securing of the work memory area and initialization of work variables, in preparation for the block arrangement.

10 The step S404 determines the order of block arrangement (block arrangement order) in the arrangement loop, in random manner.

A step S405 determines blocks B_p to be arranged (arrangement blocks) based on the block arrangement order determined in the step S404 and the number of repetition in the arrangement loop.

A step S406 determines an arrangement non-permission area corresponding to the concerned arrangement block B_p.

20 The method for deriving the arrangement non-permission area Af will be explained in the following.

The arrangement non-permission area Af is determined as a sum of the following two areas:

area 1: an area Aua where the blocks are already arranged on all the pages, as indicated by a grid pattern area shown in Fig. 20; and

area 2: an area A_C having a high correlation with the already arranged concerned block at the arrangement of the concerned arrangement block B_p , as indicated by a hatched area in Fig. 20.

5

The following area is not included in the arrangement non-permission area Af, since, if a block is arranged in a certain page, the arrangement is possible in the same area in another page:

10

area 3: an area Aup in which the block is arranged in a part of the pages, as indicated by a dotted area in Fig. 20.

15

In Fig. 20, Th_mb(Bp) and Th_sb(Bp) respectively indicate a threshold value in the main scanning direction and a threshold value in the sub scanning direction, for a concerned-block calculated in advance. The method for deriving these threshold values will be explained in the following.

A step S407 calculates an arrangeable area A_a , by reducing the arrangement non-permission area A_f from the entire block arrangement area A . Fig. 21 shows the arrangeable area A_a for the arrangement non-permission area shown in Fig. 20. The sequence proceeds to a step S408 or a step S414 respectively if the area A_a is vacant or not.

The step S408 determines an arrangement candidate area Ae by reducing the area Ac from the area A. Fig.

23 shows the arrangement candidate area Ae for the area Ac shown in Fig. 22.

A step S409 randomly determines, in the arrangement candidate area Ae, an arrangement 5 candidate page and an arrangement candidate spot for the concerned arrangement color.

A step S410 acquires the number Be of a block (hereinafter called rearrangement block) already arranged in the arrangement candidate page and the arrangement candidate spot, and discriminates whether the acquired block Be can be rearranged. Such discrimination will be explained with reference to Figs. 24 and 25.

There is calculated an area Ac_c, other than the arrangement candidate spot, having a high correlation with the already arranged block Be. Then there is determined an area Ac_s as a sum of the above-mentioned area and the area Aua in which the block is already arranged over all the pages, and a 15 rearrangeable area Ac_a is calculated by reducing the area Ac_s from the entire block arrangement area A. For example, if the area Ac_s is given as shown in Fig. 24, the rearrangeable area Ac_a is given as shown in Fig. 25. The rearrangement is judged impossible or 20 possible respectively if the area Ac_a is vacant or 25 not.

The sequence proceeds to a step S411 or S409

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respectively if the rearrangement is judged possible or impossible.

The step S411 reduces the arrangement candidate spot from the arrangement candidate area Ae.

5 A step S412 discriminates that the block arrangement failed if the area Ae becomes vacant, whereupon the sequence proceeds to the step S403. If it is not vacant, the sequence proceeds to the step S409.

10 A step S413 rearranges the rearrangement block Be
randomly in the area Ac_a, and also randomly
determines the page of arrangement, excluding the page
in which the block is already arranged in the
arrangement spot. Thereafter the concerned
15 arrangement block is arranged in the arrangement
candidate spot, and the sequence proceeds to the step
S415.

The step S414 randomly arranges the concerned arrangement block in the arrangeable area Aa, and also randomly determines the arrangement page, excluding the page in which the block is already arranged in the arrangement spot. Thereafter the sequence proceeds to the step S415.

If the step S415 identifies that the patch arrangement is completed for all the blocks, the sequence proceeds to the step S416, but, if the arrangement is not complete, the sequence proceeds to

the step S405.

If the step S416 identifies that the arrangement of all the blocks has been executed for a predetermined number of times, the sequence proceeds 5 to a step S417, but, if such predetermined number has not been reached, the sequence proceeds to the step S404.

The step S417 completes the patch image preparation.

10 In the following there will be explained the method for deriving the threshold value $Th_{mb}(B_p)$ in the main scanning direction and the threshold value $Th_{sb}(B_p)$ in the sub scanning direction for each block.

15 At first the threshold $Th_m(C_p)$ and $Th_s(C_p)$ are determined for each of all the patch colors. The threshold value $Th_m(C_p)$ is determined from the correlation between the noise and the main scanning direction and from the dispersion of the noise, and 20 the threshold value $Th_s(C_p)$ is determined from the correlation between the noise and the sub scanning direction and from the dispersion of the noise. In calculating the threshold value $Th_m(C_p)$ for the color patch C_p , there is at first calculated the 25 correlation function $f_m(x)$ between the noise and the main scanning direction in the following manner:

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$$fm(x) = \frac{1}{Rm} \iint n(s, t) (s+x, t) ds dt$$

wherein $n(s, t)$ indicates the noise signal at a position s in the x -direction and a position t in the y -direction, and Rm is a normalizing constant.

Then the correlation function $fm(x)$ is normalized 5 in the following manner by the noise dispersion v , thereby obtaining a function $fmn(x)$:

$$fmn(x) = fm(x)/v$$

Then there is determined a value x for which the function $fmn(x)$ becomes lower than a certain threshold 10 value, and such value x is defined as the threshold value $Th_m(Cp)$ for the color patch Cp . This relationship is shown in Fig. 9. In calculating the threshold value $Th_s(Cp)$ for the color patch Cp , there is at first calculated the correlation function $fs(y)$ 15 between the noise and the sub scanning direction in the following manner:

$$fs(y) = \frac{1}{Rs} \iint n(s, t) (s, t+y) ds dt$$

Then the correlation function $fs(y)$ is normalized in 20 the following manner by the noise dispersion v , thereby obtaining a function $fsn(y)$:

$$fsn(y) = fs(y)/v$$

Then there is determined a value y for which the function $fsn(y)$ becomes lower than a certain threshold

value, and such value y is defined as the threshold value $\text{Th}_s(C_p)$ for the color patch C_p . This relationship is shown in Fig. 10.

After determining the threshold values $\text{Th}_m(C_p)$ and $\text{Th}_s(C_p)$ for each of all the patch colors, there
5 are determined the threshold value $\text{Th}_{mb}(B_p)$ in the main scanning direction and the threshold value $\text{Th}_{sb}(B_p)$ in the sub scanning direction for each block, in the following manner. If the block B_p contains n color patches $C_j, C_{j+1}, \dots, C_{j+n-1}$:

$$\begin{aligned}\text{Th}_{mb}(B_p) &= \text{Max} (\text{Th}_m(C_j), \text{Th}_m(C_{j+1}), \dots, \\ &\quad \text{Th}_m(C_{j+n-1})) \\ \text{Th}_{sb}(B_p) &= \text{Max} (\text{Th}_s(C_j), \text{Th}_s(C_{j+1}), \dots, \\ &\quad \text{Th}_s(C_{j+n-1}))\end{aligned}$$

15 Thus, $\text{Th}_{mb}(B_p)$ is determined from the maximum value of the threshold values in the main scanning direction of the contained color patches, and $\text{Th}_{sb}(B_p)$ is determined from the maximum value of the threshold values in the sub scanning direction of the
20 contained color patches.

In the following there will be explained the algorithm of information processing on the patch color signal information. In the patch image preparation, by outputting the patch images through image formation
25 utilizing the patch n times for each color, the patch color signal information representing the measurement of such patch images can be obtained in n samples for

each color. The result $c(C)$ of the information processing can be obtained by the following averaging calculation:

$$c(C) = \frac{1}{n} \sum_i s(C, i)$$

5 wherein $s(C, i)$ is the patch color signal information of an i -th sample for a color C .

Such result $c(C)$ of the information processing is defined as the result of patch color measurement.

10 The present embodiment allows, by patch arrangement over plural pages in consideration of the self correlation of the noise for each path color in the patch image preparation, to relax the influence of noise in the patch measurement thereby improving the accuracy. Also the present embodiment allows, by
15 forming the patch image after formation of a block composed of plural patch images, to shorten the time required for patch image preparation and to reduce the patch arrangement order information, while maintaining the accuracy.

20 The foregoing first to fourth embodiments provide following advantages.

As explained in the foregoing, there is prepared a patch image in which plural patches are arranged for a same color, in consideration of the correlation of
25 noise in each of all the patch colors used in the

patch image. The patches are so arranged as to reduce the mutual influence of the noises resulting from the self correlation of the noises in the same patch color, so that the noise in a same patch color can be equivalently approximated by white noise. It is therefore rendered possible to eliminate the noise caused by averaging the measured information.

Thus, there can be prepared patch images capable of relaxing the influence of noise by averaging the measured information, with a fewer number of patch images.

[Other Embodiments]

Also the present invention includes a case where the program codes of a software realizing the functions of the aforementioned embodiments are supplied to a computer of a system or an apparatus connected to various devices in order to operate the devices so as to realize the functions of the aforementioned embodiments and the functions of the aforementioned embodiments are realized by operating the devices by the computer (CU or MPU) of the above-mentioned system or apparatus according to the program codes.

In such case the program codes themselves of the software realize the functions of the aforementioned embodiments, and the program codes themselves and the means for supplying the computer with such program

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codes, for example a recording medium storing the program codes, constitutes the present invention.

The recording medium storing such program codes can be, for example, a floppy disk, a hard disk, an
5 optical disk, a magneto-optical disk, a CD-ROM, a CD-R, a magnetic tape, a non-volatile memory card or a ROM.

The present invention also includes such program codes not only a case where the functions of the
10 aforementioned embodiments are realized by the execution of the read program codes by the computer but also a case where an operating system or the like functioning on the computer executes all or a part of the actual processes under the control of such program codes thereby realizing the functions of the
15 aforementioned embodiments.

The present invention further includes a case wherein the program codes read from the recording medium are once stored in a memory provided in a function expansion board inserted into the computer or
20 a function expansion unit connected to the computer, and a CPU provided in the function expansion board or the function expansion unit executes all the process or a part thereof according to the instructions of such program codes, thereby realizing the functions of
25 the aforementioned embodiments.

Although the present invention has been described in its preferred form with a certain degree of

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particularity, many apparently widely different embodiments of the invention can be made without departing from the spirit and the scope thereof. It is to be understood that the invention is not limited
5 to the specific embodiments thereof except as defined in the appended claims.

WHAT IS CLAIMED IS:

1. A patch image preparation method for forming
a patch image to be used for generating image
processing data, wherein said patch image includes
5 plural patches relating to a same color, and said
plural patches of the same color are arranged so as to
reduce the mutual influence of noise color signals,
resulting from the self correlation of the noise color
signals in the plural patches of the same color.
- 10 2. A method according to Claim 1, wherein said
plural patches of the same color are not arranged
within a distance set in advance in the main and sub
scanning directions.
- 15 3. A method according to Claim 1, wherein the
kind and the number of patches included in said patch
image are set according to the designation of the
user.
- 20 4. A method according to Claim 1, further
comprising steps of:
forming a block image including plural
patches; and
25 arranging said block image so as to reduce
the mutual influence of noise color signals, resulting
from the self correlation of the noise color signals

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in the plural patches of the same color.

5. A method according to Claim 4, further comprising steps of:

5 deriving, from the plural patches belonging to said block image, self correlation of the noise color signals in said block image based on the self correlation of the noise color signal in each of the plural patches;

10 deriving, from said block image, a high correlation area in which the arrangement of said block image is inhibited, based on said derived self correlation of the noise color signal and the positions of the same block image already arranged;

15 deriving an already arranged area in which the block image is arranged; and

arranging said block image in an arrangeable area excluding said high correlation area in which the arrangement of the block image is inhibited and said 20 already arranged area.

6. A method according to Claim 5, further comprising steps of:

25 discriminating whether said arrangeable area, excluding said high correlation area and said already arranged area, is vacant;

arranging said block image in the arrangeable

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area in case the result of said discrimination
indicates that said arrangeable area is vacant; and
arranging said block image in an area
excluding said high correlation area and rearranging
5 the block image present in said already arranged area
in another area, in case the result of said
discrimination indicates that said arrangeable area is
not vacant.

10 7. A patch image preparation method for
preparing a patch image including plural patches of a
same color, wherein, for each patch color, the patches
are so arranged as to reduce the mutual influence of
the noise color signals resulting from self
15 correlation of the noise color signals in the same
patch color, in order that the noise color signal of
the same patch color can be approximated equivalently
as white noise.

20 8. A patch image preparation method for
preparing a patch image by arranging patches in
succession according to Claim 5, further comprising:
 a step of deriving, for a patch, a high
correlation area in which the arrangement of said
25 patch is inhibited, from the self correlation of the
noise color signals of the same patch color and the
position of the already arranged patch of the same

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color;

a step of deriving an already arranged area
in which a patch is already arranged; and

5 a step of arranging said patch in an
appropriate position in an arrangeable area excluding
said high correlation area and said already arranged
area.

10 9. A patch image preparation method for
preparing patch images over plural pages according to
Claim 8, wherein, in the step for deriving said
already arranged area, an already arranged area in
which a patch is already arranged is defined only in
case a patch is arranged in a same position over all
15 the pages.

10. A patch image preparation method comprising
steps of:

20 preparing a basic patch image for a color to
be used as a patch;
 preparing a rotated image obtained by a
rotating operation on said basic patch image; and
 arranging said rotated image in an
appropriate image position.

25 11. A computer readable recording medium storing
a program for a patch image preparation method for

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forming a patch image including plural patches of a same color to be used for generating image processing data, the method being featured by that said plural patches of the same color are arranged so as to reduce 5 the mutual influence of noise color signals, resulting from the self correlation of the noise color signals in the plural patches of the same color.

12. A computer readable recording medium storing 10 a program of a patch image preparation method for preparing a patch image including plural patches of a same color, the program being featured by a fact that, for each patch color, the patches are so arranged as to reduce the mutual influence of the noise color 15 signals resulting from self correlation of the noise color signals in the same patch color, in order that the noise color signal of the same patch color can be approximated equivalent as white noise.

20 13. A computer readable recording medium storing a program for a patch image preparation method, the method comprising steps of:

preparing a basic path image for a color to be used as a patch;

25 preparing a rotated image obtained by a rotating operation on said basic patch image; and arranging said rotated image in an appropriate image position.

ABSTRACT OF THE DISCLOSURE

The invention is to relax the influence of noise with patch images of a number as small as possible, in consideration of the correlation of noise. For
5 attaining this objective, in the preparation of a patch image to be used for generating image processing data, the patch image is made to include plural patches of a same color and such plural patches of the same color are so arranged as to reduce the mutual
10 influence of the noise color signals by the self correlation of the noise color signal in the plural patches of the same color.

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FIG. 1

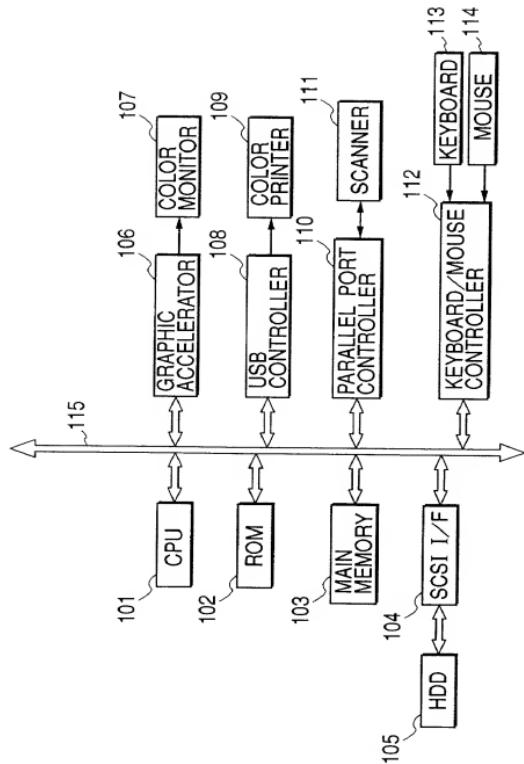


FIG. 2

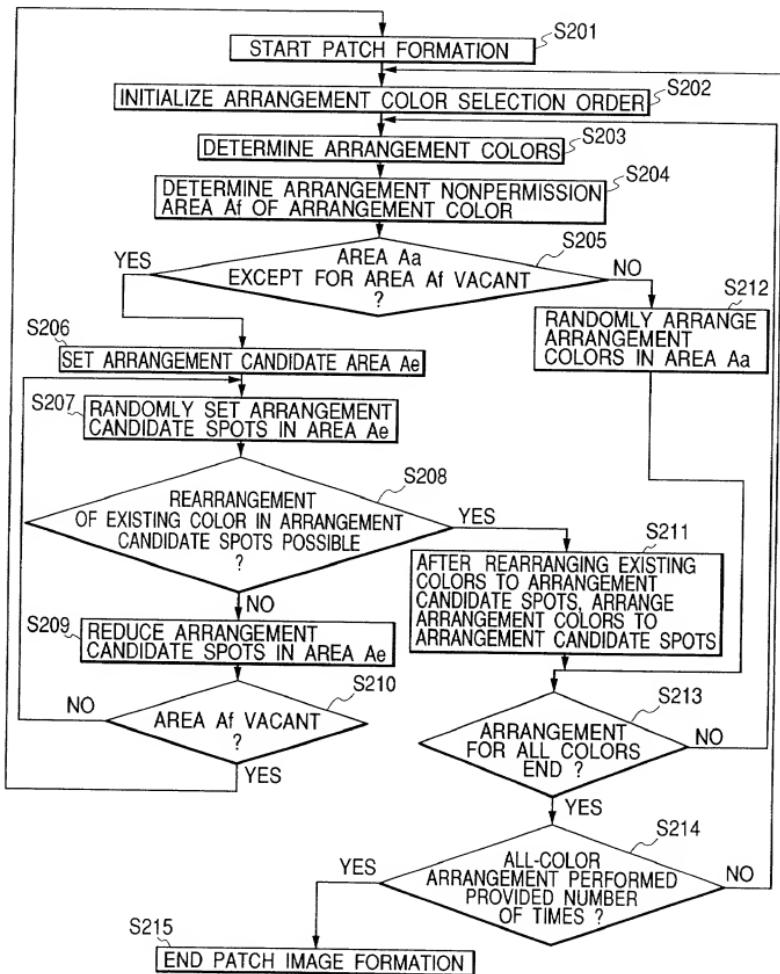


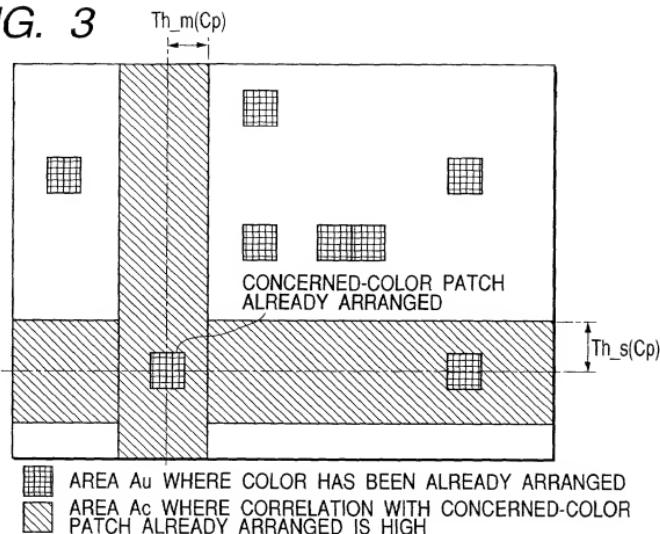
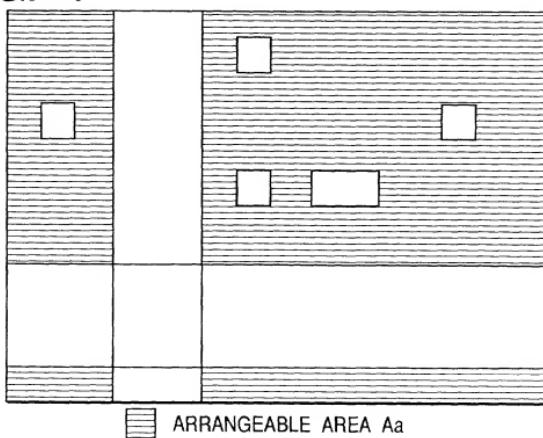
FIG. 3**FIG. 4**

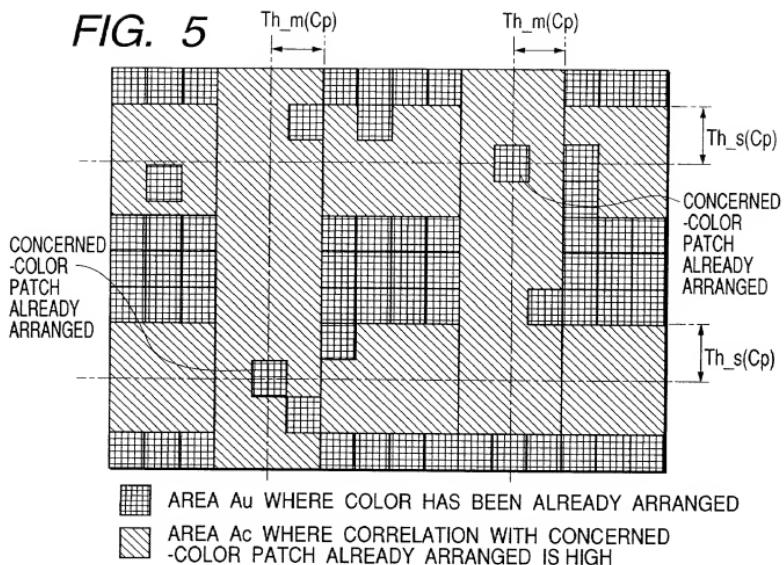
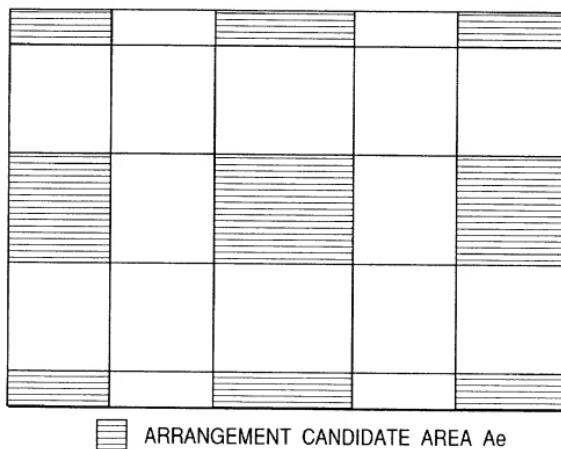
FIG. 5**FIG. 6**

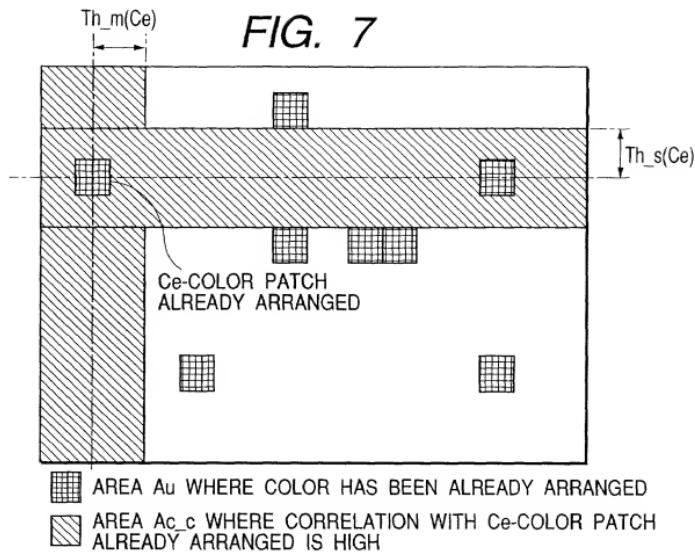
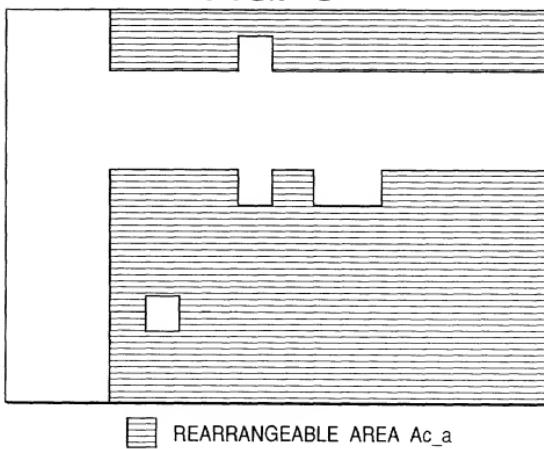
FIG. 7***FIG. 8***

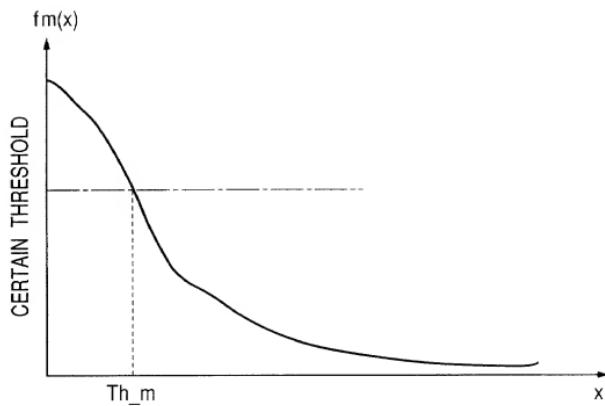
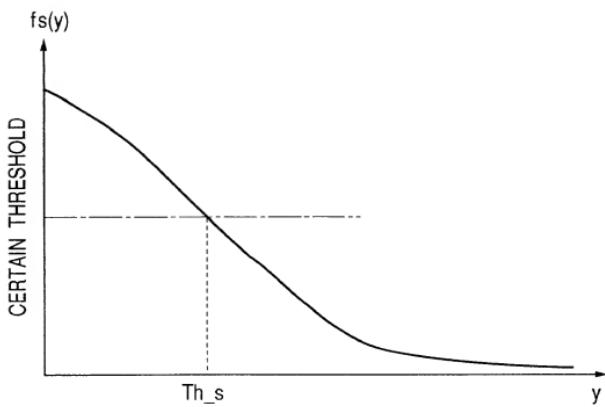
FIG. 9*FIG. 10*

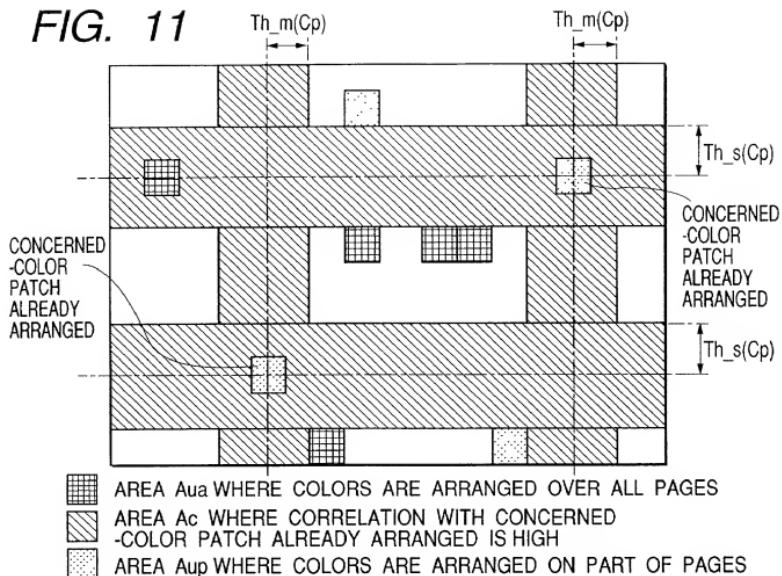
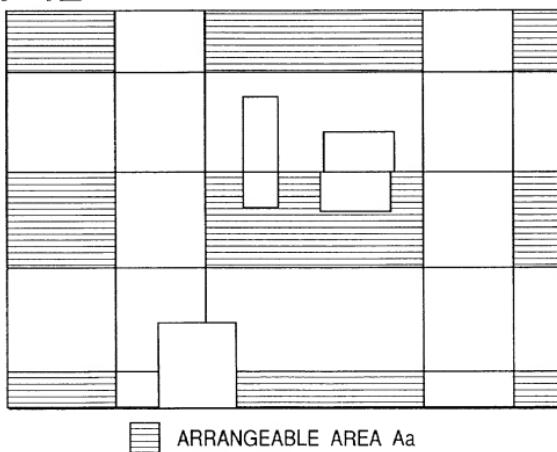
FIG. 11**FIG. 12**

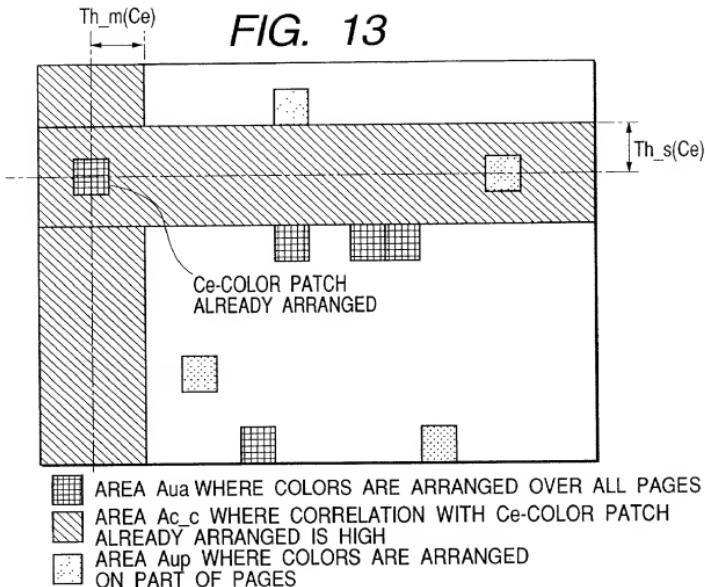
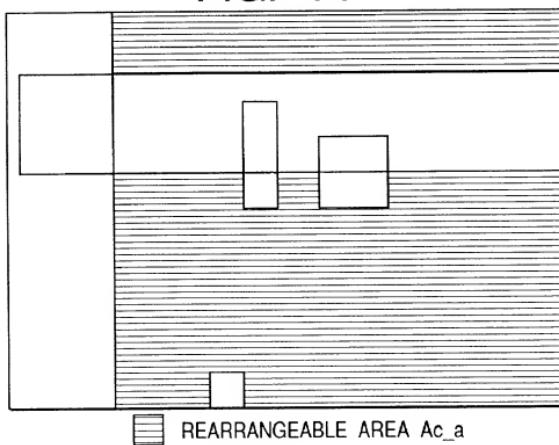
FIG. 13**FIG. 14**

FIG. 15

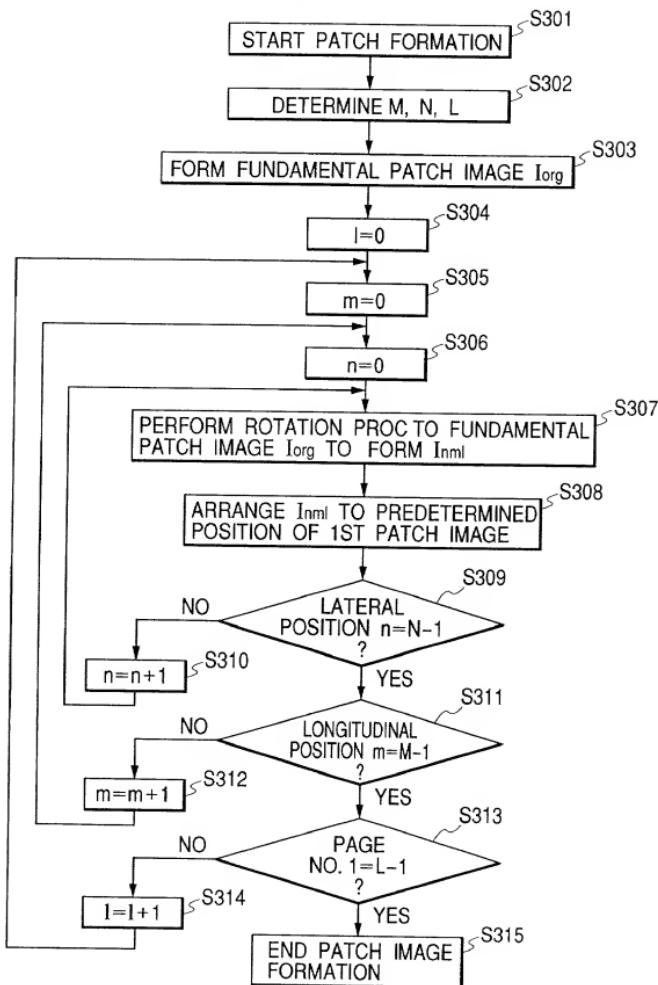
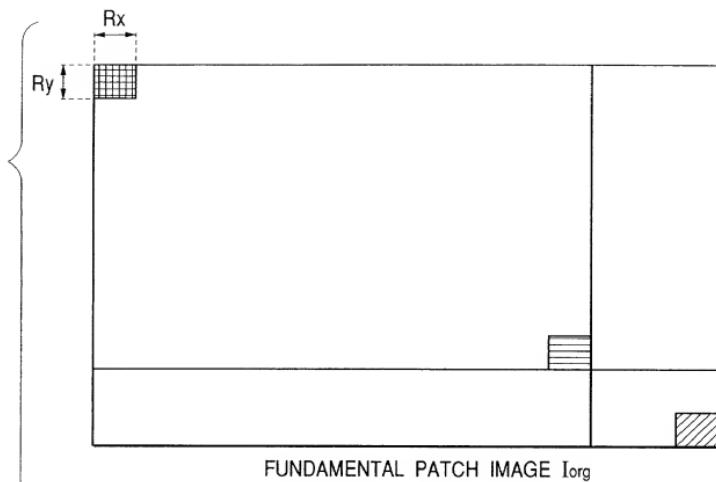
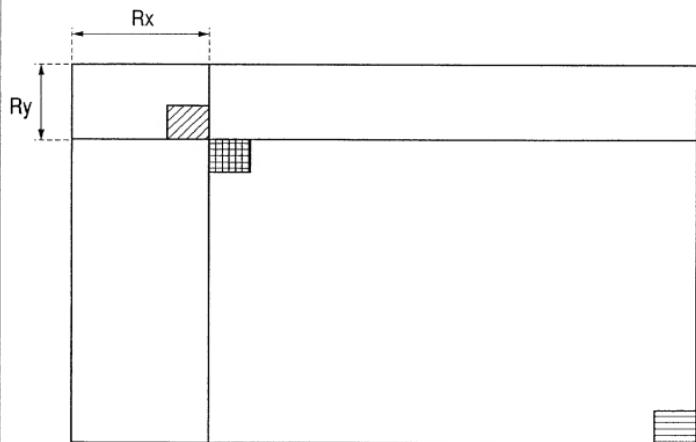
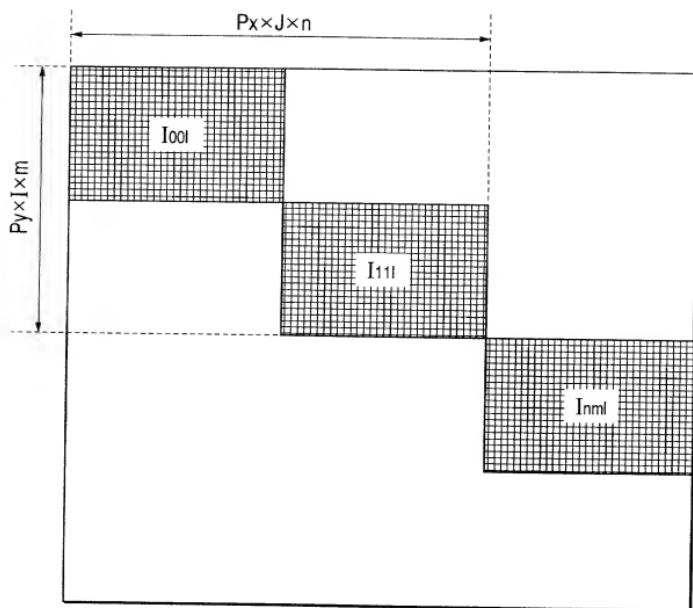


FIG. 16

FUNDAMENTAL PATCH IMAGE I_{org} ROTATED IMAGE I_{rot}

C1 COLOR PATCH C2 COLOR PATCH C3 COLOR PATCH

FIG. 17

1ST PATCH IMAGE

FIG. 18

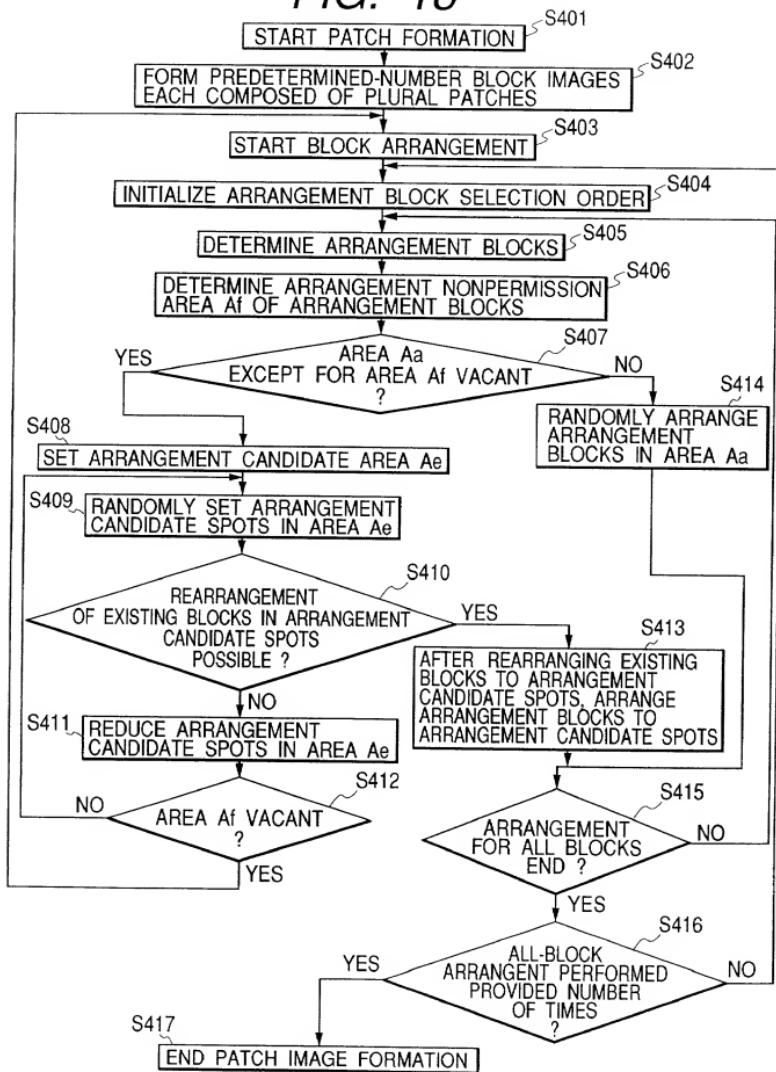


FIG. 19

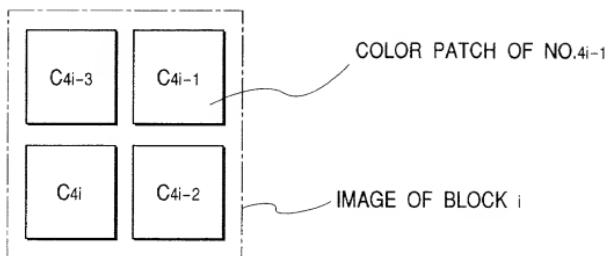


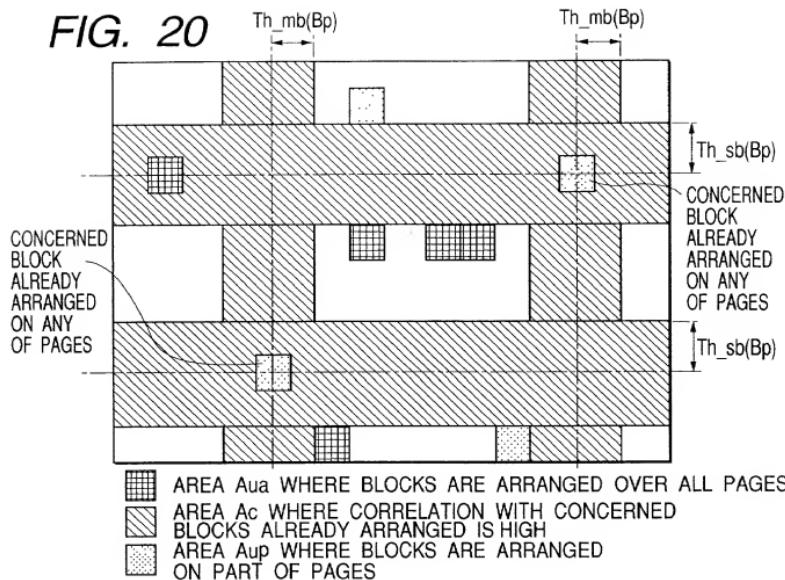
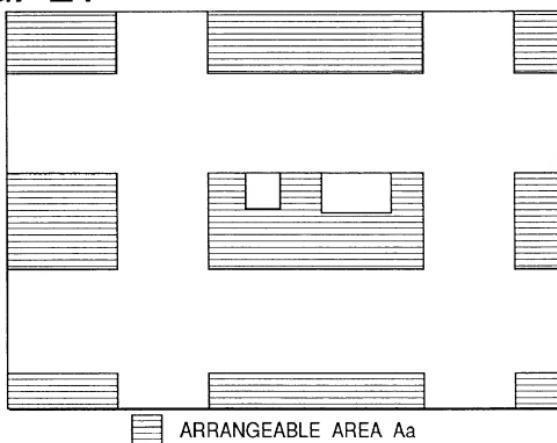
FIG. 20**FIG. 21**

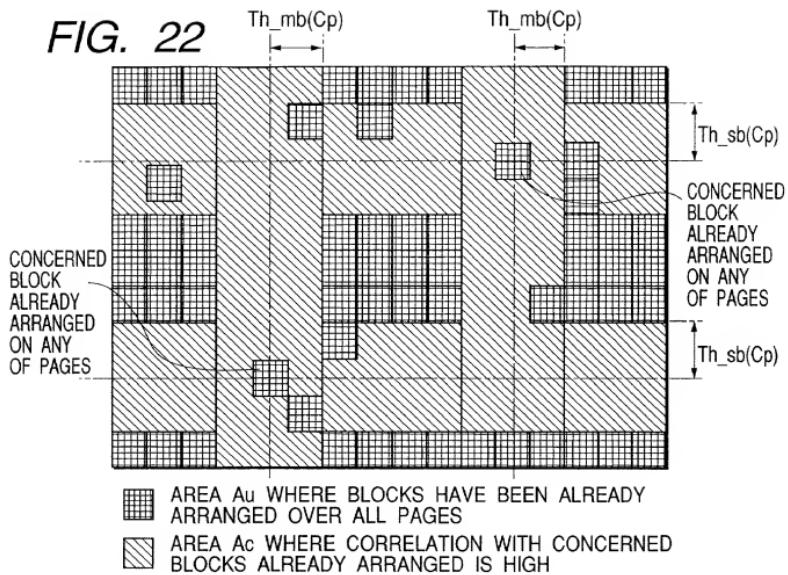
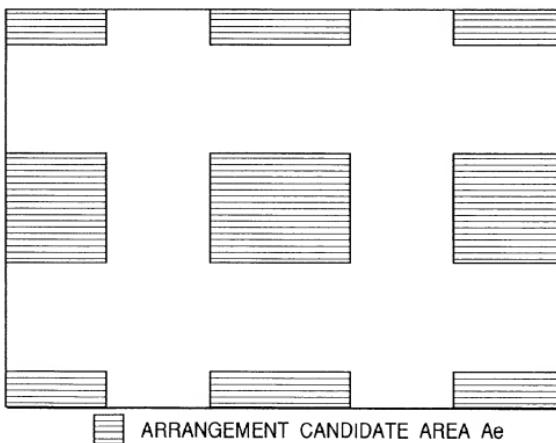
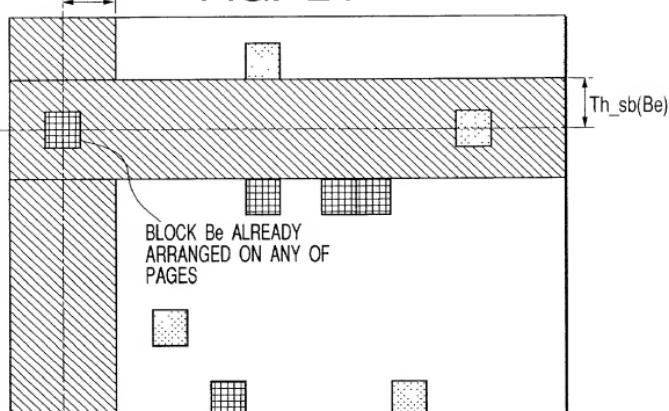
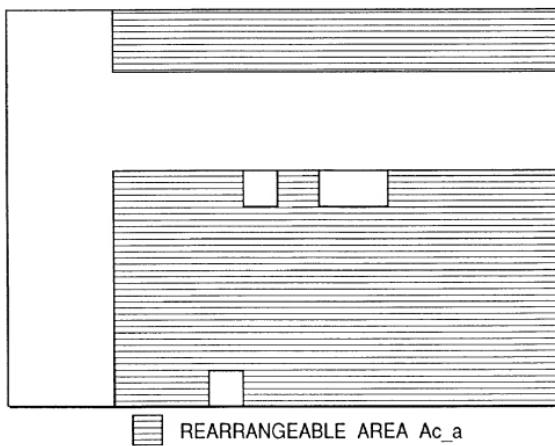
FIG. 22**FIG. 23**

FIG. 24

- AREA Aua WHERE BLOCKS ARE ARRANGED OVER ALL PAGES
- AREA Ac_c WHERE CORRELATION WITH BLOCKS Be
- AREA Ac_c WHERE CORRELATION WITH BLOCKS Be ALREADY ARRANGED IS HIGH
- AREA Aup WHERE BLOCKS ARE ARRANGED ON PART OF PAGES

FIG. 25

**COMBINED DECLARATION AND POWER OF ATTORNEY
FOR PATENT APPLICATION**
(Page 1)

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled PATCH IMAGE PREPARATION METHOD AND RECORDING MEDIUM THEREFOR,

the specification of which is attached hereto was filed on _____ as United States Application No. or PCT International Application No. _____ and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR §1.56.

I hereby claim foreign priority benefits under 35 U.S.C. §119(a)-(d) or §365(b), of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT international application which designates at least one country other than the United States, listed below and have also identified below any foreign application for patent or inventor's certificate, or PCT international application having a filing date before that of the application on which priority is claimed:

Country	Application No.	Filed (Day/Mo/Yr.)	Priority Claimed
Japan	11-217217	30/07/99	Yes
Japan	2000-211210	12/07/00	Yes

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s), or § 365(c) of any PCT international application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 C.F.R. § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

Application No. _____ Filed (Day/Mo/Yr.) _____ Status (Patented, Pending, Abandoned) _____

I hereby appoint the practitioners associated with the firm and Customer Number provided below to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and direct that all correspondence be addressed to the address associated with that Customer Number

FITZPATRICK, CELLA, HARPER & SCINTO
Customer Number: 05514

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole or First Inventor HIROCHIKA MATSUOKA

Inventor's signature _____

Date _____ Citizen/Subject of Japan

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